

Amendments to the Claims:

Claims 1-30 are pending in this application. Please cancel claims 5, 23-25 and 29, amend claims 1 and 26, and add new claims 31-44 as provided below.

1 1. (currently amended) A data management appliance, comprising:
2 a random-access storage unit storing a forward journal and a backward
3 journal; and
4 control circuitry adapted to receive commands from a host computer
5 system, the control circuitry combining the commands to obtain a net change, the
6 control circuitry deriving an inverse of the net change based on a starting address and
7 lengths associated with the net change, the inverse of the net change recorded as a
8 snapshot in the backward journal,
9 wherein in response to the control circuitry receiving a write command
10 from the computer system, the control circuitry updates the random-access storage
11 unit to include information associated with the write command and
12 in response to a read command including a logical address and a time
13 value, the control circuitry retrieves, from the random-access storage unit, data
14 representing contents of the logical address at a time represented by the time value.

1 2. (original) The data management appliance of claim 1, wherein the
2 write commands are replicated from write commands issued to a primary storage
3 device.

1 3. (original) The data management appliance of claim 1, wherein the
2 write commands are received from the computer system through a replicating
3 controller.

1 4. (original) The data management appliance of claim 1, wherein the
2 write commands are replicated by the computer system.

1 5. (canceled).

1 6. (original) The data management appliance of claim 1, wherein the
2 random-access storage unit stores a mirror-in-the-middle (MIM) containing a copy
3 of contents of a primary storage device at a fixed point in time.

1 7. (original) The data management appliance of claim 6, wherein the
2 random-access storage unit stores at least one snapshot containing changes, that when
3 made to contents of the mirror-in-the-middle (MIM), would result in a previous
4 version of the contents of the primary storage device.

1 8. (original) The data management appliance of claim 7, wherein the
2 control circuitry stores a mapping object, wherein the mapping object maps logical
3 addresses into physical addresses on the mirror-in-the-middle (MIM) and contained
4 in the at least one snapshot.

1 9. (original) The data management appliance of claim 1, wherein the
2 control circuitry receives commands from the computer system through a storage
3 network.

1 10. (original) The data management appliance of claim 1, wherein
2 the random-access storage unit includes memory.

1 11. (original) The data management appliance of claim 1, wherein
2 the random-access storage unit includes a disk.

1 12. (original) A data management appliance comprising:
2 a random-access storage unit; and
3 control circuitry adapted to receive commands from a computer
4 system,

5 wherein in response to the control circuitry receiving a write command
6 from the computer system, the control circuitry updates the random-access storage
7 unit to include information associated with the write command;
8 in response to a mount command including a time value, the control
9 circuitry configures itself to perform future read operations with respect to a fixed
10 time represented by the time value; and
11 in response to a read command including a logical address, the control
12 circuitry retrieves, from the random-access storage unit, data representing contents
13 of the logical address at the fixed time.

1 13. (original) The data management appliance of claim 12, wherein
2 the write commands are replicated from write commands issued to a primary storage
3 device.

1 14. (original) The data management appliance of claim 12, wherein
2 the write commands are received from the computer system through a replicating
3 controller.

1 15. (original) The data management appliance of claim 12, wherein
2 the write commands are replicated by the computer system.

1 16. (original) The data management appliance of claim 12, wherein
2 the random-access storage unit stores a forward journal.

1 17. (original) The data management appliance of claim 12, wherein
2 the random-access storage unit stores a mirror-in-the-middle (MIM) containing a copy
3 of contents of a primary storage device at a fixed point in time.

1 18. (original) The data management appliance of claim 17, wherein
2 the random-access storage unit stores at least one snapshot containing changes, that

3 when made to contents of the mirror-in-the-middle (MIM), would result in a previous
4 version of the contents of the primary storage device.

1 19. (original) The data management appliance of claim 18, wherein
2 the control circuitry stores a mapping object, wherein the mapping object maps
3 logical addresses into physical addresses on the mirror-in-the-middle (MIM) and
4 contained in the at least one snapshot.

1 20. (original) The data management appliance of claim 12, wherein
2 the control circuitry receives commands from the computer system through a storage
3 network.

1 21. (original) The data management appliance of claim 12, wherein
2 the random-access storage unit includes memory.

1 22. (original) The data management appliance of claim 12, wherein
2 the random-access storage unit includes a disk.

1 23.-25. (canceled).

1 26. (currently amended) The data management appliance of claim 1
2 ~~23~~ wherein a mirror-in-the-middle is updated to reflect the net change.

1 27. (previously presented) The data management appliance of claim
2 16, wherein commands stored in the forward journal are combined to obtain a net
3 change.

1 28. (previously presented) The data management appliance of claim
2 27, wherein starting address and lengths associated with the net change are used to
3 derive an inverse of the net change.

1 29. (canceled).

1 30. (previously presented) The data management appliance of claim
2 27, wherein a mirror-in-the-middle is updated to reflect the net change.

1 31. (new) A data management appliance comprising:
2 a random-access storage unit storing a forward journal including a
3 plurality of write commands and a backward journal; and
4 control circuitry adapted to receive the plurality of write commands
5 from a computer system and to combine the plurality of write commands to obtain a
6 net change, the control circuitry deriving an inverse of the net change based on
7 starting address and lengths associated with the net change, the control circuit storing
8 the inverse of the net change as a snapshot in the backward journal;
9 wherein in response to the control circuitry receiving a write command
10 from the computer system, the control circuitry updates the random-access storage
11 unit to include information associated with the write command;
12 in response to a mount command including a time value, the control
13 circuitry configures itself to perform future read operations with respect to a fixed
14 time represented by the time value; and
15 in response to a read command including a logical address, the control
16 circuitry retrieves, from the random-access storage unit, data representing contents
17 of the logical address at the fixed time.

1 32. (new) A method of replicating data written to a data storage
2 system, the method comprising:
3 creating a mirror-in-the middle (MIM) recording an exact copy of the
4 data storage system at a fixed point in time;
5 recording a forward journal holding write events received since the
6 fixed point in time;

7 receiving a request to access replicated data as the replicated data
8 existed at a requested time, the requested time more recent than the fixed point in
9 time; and

10 constructing a virtual recovery mapping object (VRMO) from the
11 forward journal based on the requested time, the VRMO translating received logical
12 addresses representing locations on the data storage system to physical locations of
13 the replicated data, the VRMO implemented in a random access structure, the VRMO
14 referencing replicated data as a copy of data written to the data storage system since
15 the fixed point in time.

1 33. (new) The method of replicating data as in claim 32 wherein the
2 random access structure is a binary search tree.

1 34. (new) The method of replicating data as in claim 32 wherein the
2 random access structure is a multi-way search tree.

1 35. (new) The method of replicating data as in claim 32 wherein the
2 VRMO is indexed with respect to blocks of data contained in the MIM.

1 36. (new) The method of replicating data as in claim 32 wherein the
2 VRMO is indexed with respect to logical addresses contained within the forward
3 journal.

1 37. (new) The method of replicating data as in claim 34 wherein the
2 request to access replicated data is a read request.

1 38. (new) The method of replicating data as in claim 34 wherein the
2 request to access replicated data is a mount request.

1 39. (new) The method of replicating data as in claim 34 further
2 comprising:
3 producing a plurality of snapshots from forward journal entries, the
4 plurality of snapshots reflecting changes in the data storage system over time; and
5 storing the plurality of snapshots in a backward journal.

1 40. (new) The method of replicating data as in claim 39 further
2 comprising:
3 updating the MIM as each snapshot is produced;
4 discarding forward journal entries used to update the MIM; and
5 updating the fixed point in time.

1 41. (new) The method of replicating data as in claim 39 further
2 comprising:
3 creating backward journal entries based on the VRMO and entries in
4 the forward journal; and
5 producing a new snapshot based on the backward journal entries and
6 the VRMO.

1 42. (new) The method of replicating data as in claim 32 wherein the
2 VRMO is one of a plurality of VRMOs, each VRMO based on a different requested
3 time.

1 43. (new) The data management appliance of claim 1, wherein the
2 random-access storage unit stores at least one mapping object, each mapping object
3 mapping logical addresses into physical addresses for a particular point in time.

1 44. (new) The data management appliance of claim 12, wherein the
2 random-access storage unit stores at least one mapping object, each mapping object
3 mapping logical addresses into physical addresses for a particular point in time.